(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICANT:	GU, WENBIN ET AL.
GROUP ART UNIT:	1795
EXAMINER:	WALKER, KEITH D.
TITLE:	CAPILLARY LAYER ON FLOWFIELD FOR WATER MANAGEMENT IN PEM FUEL CELL
ATTORNEY DOCKET:	8540G-000187 (GP-303100)

APPEAL BRIEF

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is an appeal from the Office Action mailed December 2, 2009, finally rejecting Claims 1-2, 5, 7-12, 15-23, 51, 53, 55-66 and 68-75. A Notice of Appeal was filed on March 2, 2010. This appeal is being submitted with the accompanying fee and a petition for a one month extension of time under 37 C.F.R. §1.136(a) to extend the due date to June 2, 2010.

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I. Real Party In Interest

The real party in interest is GM Global Technology Operations Inc. Assignments from the inventors to assignee, General Motors Corporation, were executed on February 4 and 5, 2004 and recorded with the U.S. Patent and Trademark Office at Reel/Frame No. 014993/0825 on February 17, 2004. An assignment from General Motors Corporation to assignee, GM Global Technology Operations, Inc., was executed on January 19, 2005 and recorded with the U.S. Patent and Trademark Office on January 13, 2009 at Reel/Frame No. 022092/0737.

II. Related Appeals, Interferences, And Judicial Proceedings

There are no other appeals, interferences, or judicial proceedings which will directly affect, be directly affected by, or have a bearing on the Board's decision in this appeal.

III. Status Of Claims

Claims 1-2, 5, 7-12, 15-23, 51, 53, 55-66 and 68-75 are finally rejected. Claims 13-14 were withdrawn from consideration. Claims 3-4, 6, 24-50, 52, 54 and 67 have been cancelled. The claims on appeal are Claims 1-2, 5, 7-12, 15-23, 51, 53, 55-66 and 68-75.

IV. Status Of Amendments

Applicants filed a Response After Final Rejection on February 1, 2010 pursuant to 37 C.F.R. §1.116. No claim amendments were introduced.

V. Summary Of Claimed Subject Matter

The rejected claims include three independent claims (Claims 1, 51, and 64), which share various common features. Claims 51 and 64 are further patentably

distinguishable over the cited art and, thus, are treated separately below. Likewise, Claims 8, 56 and 69 share additional common, patentably distinguishable features over the cited art, as do Claims 7, 55 and 68, so that these claims are also treated separately below. Accordingly, these claims are grouped together in the discussion below.

A. Claims 1-2, 5, 8-11, 16-21 and 23

Independent Claim 1 recites an electrochemical cell having a membrane electrode assembly (MEA) *60* with an anode *64* and a cathode *66*. Figures 1-2; page 1, lines 12-14; page 2, lines 8-10; page 9, lines 10-12. The cell comprises a porous liquid distribution media (LDM) *82* that is disposed along a major surface *84* of an impermeable, electrically conductive element *80*. Page 14, line 11 to page 20, line 18; Figures 2-3. The LDM *82* is electrically conductive. Page 19, line 19 to page 20, line 4; page 21, line 18 to page 22, line 6. Further, the LDM *82* defines flow channels *72* comprising lands *74* and grooves *76* to transport gas and liquid to and from the cathode *66*. Figures 2-3, 8-9; page 2, lines 11-14; page 14, lines 15-20; page 15, lines 11-22; page 16, lines 1-2; p. 21, line 18 to page 22, line 14; page 23.

The cell also comprises a fluid distribution layer *68*, which is disposed between the LDM *82* and the cathode *66*. Figure 2, 8-9; page 2, lines 14-17; page 10, lines 12-16, page 11, lines 1-2. The fluid distribution layer (FDL) 68 transports fluids and liquids (reactants and products) between the cathode *66* of the MEA 60 and flow channels *72* of the LDM *82*. Figures 2 and 8-9; page 10, lines 4-14; page 20, lines 9-18. The LDM *82* contacts the FDL *68* in regions corresponding to the lands *74* to form an electrically conductive path between the impermeable electrically conductive element *80* and the conductive FDL *68*. Page 12, line 22 to page 13, line 12; page 14, line 11 to page 15, line 10; page 21, line 18 to page 22, line 14; page 23, lines 18-21; figures 2-3 and 8-10.

The LDM *82* serves to wick and distribute liquids generated at the cathode *66* and transported through the FDL *68*, thus maintaining uniform water distribution and humidity across the entire surface of the MEA *60* to improve cell performance, durability, and longevity. See Page 14, line 15 to page 16, line 2; page 33, line 22 to page 34, line 2. The LDM *82* also enhances electrochemical cell performance by reducing mass transfer resistance by effectively separating gas and liquid transport paths in the active area of the cell. Page 14, line 15 to page 16, line 2.

Independent Claims 51 and 64 recite these common features of an electrochemical cell, but differ from Claim 1 as further discussed below.

Additionally, in Claim 1 the FDL *68* is also porous like the LDM *82,* but is specified to have an average pore size that is larger than an average pore size of the LDM *82*. Page 20, lines 19-22. Thus, the invention of Claim 1 provides a self-regulated water management system, where water is internally distributed within the LDM *82* and vaporized or entrained by gases passing over the LDM *82*. Page 33, lines 12-15. The claimed features result in enhanced water removal, reduced potential for electrode flooding, and increased mass transport to regions of lower liquid concentration to promote higher fuel cell operational efficiency and lower electrical resistance loss. Page 33, lines 16-22.

Claims 2, 5-12, and 15-23 depend on Claim 1; however, dependent Claims 7-8, 12, 15, and 22 are discussed separately below.

B. Claims 12, 51, 53, 55-63, 65 and 75

Independent Claim 51 shares common features with independent Claim 1 as noted above. Claim 51 and its dependent Claims 53, 55-63, 65, and 75 further include a liquid distribution media (LDM) *82'''* that comprises a first layer *102* and a second layer *100*. Page 23, line 22 to page 24, line 6; figure 9. The LDM *82'''* is arranged so that the

first layer *102* contacts the impermeable electrically conductive element 80'''. Figure 9; page 24, lines 14-16. The second layer *100* contacts the fluid distribution layer (FDL) *68* in regions corresponding to lands *74*, thus forming an electrically conductive path between the impermeable electrically conductive element *80'''*and the conductive FDL *68*. Figure 9; page 23, lines 18-21; page 24, lines 2-14; page 12, line 22 to page 13, line 12; page 14, line 11 to page 15, line 10; page 21, line 18 to page 22, line 14. The FDL *68* is porous and is specified in Claim 51 to have an average pore size larger than an average pore size of the second layer *100* of the porous LDM *82'''*. Page 24, lines 8-16. Furthermore, the first layer *102* of the LDM *82* (contacting the electrically conductive element *80'''*) is less hydrophilic than the second layer *100* (contacting the FDL *68*). Page 24, lines 6-20.

Claim 12, which depends upon Claim 1, similarly recites that the LDM *82* comprises a first layer *102* in contact with the impermeable electrically conductive element *80'''* and a second layer *100* in contact with the FDL *68*. The second layer *100* is more hydrophilic than the first layer *102*.

C. Claims 15, 64-66 and 68-74

Independent Claim 64 likewise shares several common features with independent Claim 1 as noted above. Claim 64 further specifies that the LDM *82* comprises a material selected from the group consisting of: mesh, screen, foam, and sintered metal. Page 21, line 18 to page 22, line 14; page 26, line 14 to page 32, line 5; page 14, line 11 to page 16, line 2.

Claims 65-66 and 68-74 depend upon Claim 64.

Claim 15, which depends upon Claim 1, and includes Claim 1's limitation that the porous FDL *68* has an average pore size that is larger than an average pore size of the porous LDM *82*. Claim 15 is similar to Claim 64 in reciting that the LDM *82* is

selected from mesh, screen, foam, and sintered metal materials. Page 20, lines 19-22.

D. Claims 7, 55 and 68

Claims 7, 55, and 68 share a common feature that further patentably distinguishes them over the cited art. These claims call for the liquid distribution media (LDM) *82* to be disposed in regions along the major surface *84* of the impermeable electrically conductive element *80* corresponding to an electrically active area defined by the MEA *60*. Page 12, line 22 to page 13, line 5.

E. Claims 8, 56 and 69

Claims 8, 56, and 69 also recite a common non-obvious feature that further defines over the cited art. The impermeable electrically conductive element *80* is planar and a body of the liquid distribution media (LDM) *82* defines an undulated configuration of peaks (lands) *74''* and valleys (grooves) *76''*. Figure 8; page 23, lines 10-16. The peaks correspond to lands *74''* and the valleys correspond to grooves 76″ which constitute the flow channels *72*. Page 23, lines 16-21. Thus, the LDM is a structurally independent element that forms lands and grooves defining flow channels.

F. Claim 22

Claim 22, which depends upon Claim 1, is separately rejected because it recites an impermeable electrically conductive element *80* that comprises a compound selected from the group consisting of: aluminum, titanium, stainless steel, and alloys and mixtures thereof. Page 13, lines 18-19.

VI. Grounds Of Rejection To Be Reviewed On Appeal

A. Claims 1-2, 5, 7-12, 15-21, 23, 51, 53, 55-66 and 68-75 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Miyazawa (U.S. Pat. Pub. No. 2003/0235735) in view of Yamada (U.S. Pat. No. 5,432,023).

B. Claim 22 stands rejected under 35 U.S.C. § 103(a) over Miyazawa (U.S. Pat. Pub. No. 2003/0235735) in view of Yamada (U.S. Pat. No. 5,432,023) and Davis (U.S. Pat. Pub. No. 2002/0001743).

VII. Argument

A. Claims 1-2, 5, 8-11, 16-21, and 23 are not rendered *prima facie* obvious by the combination of *Miyazawa* and *Yamada* because neither reference teaches a porous conductive liquid distribution media disposed on a land forming an electrically conductive path between the impermeable electrically conductive element and the fluid distribution layer and both references teach away from such a configuration.

The combination of cited art, *Miyazawa* in view of *Yamada,* fails to establish a *prima facie* case of obviousness for three reasons. First, the combined teachings of these references fail to teach each and every limitation of the claimed invention. *KSR v. Teleflex* has not affected the fundamental requirement that each and every claim limitation must be found in the combination of the prior art references before the obviousness analysis proceeds. *Abbott Labs. v. Sandoz, Inc*., 89 USPQ.2d 1161, 1171 (Fed. Cir. 2008). Neither *Miyazawa* nor *Yamada* teaches the claimed electrically conductive porous liquid distribution media. Second, neither *Miyazawa* nor *Yamada* teaches a liquid distribution media disposed on lands of the impermeable electrically conductive element to define flow channels and to form an electrically conductive path between a fluid distribution layer and an impermeable electrically conductive element, as recited in independent Claims 1, 51, and 64 and their dependent claims. Lastly, the combination of *Miyazawa* and *Yamada* teaches away from the claimed invention having

a conductive porous liquid distribution media disposed on the lands of electrically conductive element that form an electrically conductive path, because *Yamada* teaches away from modifying *Miyazawa* to have an electrically conductive porous liquid distribution media (LDM) on lands of an impermeable separator element to form electrically conductive paths inside the fuel cell.

The following discussion, while focusing on Claim 1 and its dependent Claims 2, 5, 8-11, 16-21, and 23, also pertains to Claims 7, 12, 15, 51, 53, 55-66, and 68-75. (Claims 7, 12, 15, 51, 53, 55-66, and 68-75 are discussed separately for reciting additional patentable features, in addition to those discussed in the context of independent Claim 1.) As such, whether considered independently or as combined, *Miyazawa* and *Yamada* fail to render any of Claims 1-2, 5, 7-12, 15-21, 23, 51, 53, 55-66 and 68-75 *prima facie* obvious.

1. <u>*Miyazawa* fails to teach a porous liquid distribution media (LDM) of Claims 1-2, 5, 8-11, 16-21, and 23.</u>

The Examiner misinterprets the primary reference, *Miyazawa*, as providing a <u>porous</u> liquid distribution media (LDM). Without pointing to any actual support in *Miyazawa*, the Examiner mistakenly asserts that *Miyazawa's* hydrophilic membrane 14 is porous. Final Office Action dated December 2, 2009, p. 3. Yet, there is no indication whatsoever in *Miyazawa* that membrane 14 is porous. The Examiner's bold, conclusory statement fails to support a *prima facie* rejection. It is incumbent on an examiner to not merely reproduce Applicant's claim language with a citation to the reference, but further to explain how the cited disclosure in fact describes what is in the claim. *See In re Glaug*, 283 F.3d 1335, 1340 (Fed. Cir. 2002) ("Although Solicitor states that [the prior art] expressly teaches 'applying adhesive' in 'spaced apart zones,' these words are

quoted from [applicant] not [the prior art reference].") The Examiner has failed to explain how *Miyazawa* describes a porous LDM.

Miyazawa describes forming a hydrophilic membrane coating 14, but does not indicate that the coating 14 is porous. *Miyazawa* specifies that "hydrophilic membrane 14 is formed by coating a slurry or a coating containing a hydrophilic material onto only the bottom 13 and both wall faces 12 of the gas flow groove 7." ¶[0038]. *Miyazawa's* examples provide that "the coating for forming the hydrophilic membrane 14 … includes carbon black, liquid phenol and polyvinyl alcohol all dissolved in methanol. The coating is performed by an air spray process and dried in order to form the hydrophilic membrane 14." ¶[0038]. The coating is dried and then blasted from the top surface 23 of separator 4. ¶[0038].

Such a coating is indeed hydrophilic; however, there is no reason to believe it is porous. Simply because *Miyazawa* describes it as hydrophilic does not mean it must also be porous. One of ordinary skill in the art recognizes that porosity and hydrophilicity are distinct physical properties. Missing from the record is any evidence that that *Miyazawa's* conductive hydrophilic polymer coating 14 is porous or that porosity and hydrophilicity are necessarily linked here. Indeed, one reason *Miyazawa* indicates that the hydrophilic membrane 14 must be removed from the rib's contact surface 23 is to avoid the resultant reduction in porosity that would otherwise be caused by its presence, presumably by occluding the pores of porous rib 11. ¶[0033].

Since the obviousness rejection relies upon the misapprehension that hydrophilic coating 14 is porous, the rejection is deficient for failing to articulate a reason to modify *Miyazawa* to replace its disclosed coating with a porous liquid distribution media. For this reason alone, the rejection fails to establish a *prima facie* case of obviousness.

2. *Miyazawa* does not teach a liquid distribution media (LDM) formed on lands of an impermeable electrically conductive separator, but rather teaches away from the configuration in Claims 1-2, 5, 8-11, 16-21, and 23.

The Examiner also incorrectly interprets the teachings of *Miyazawa* to have a liquid distribution media (LDM) disposed on lands of an impermeable electrically conductive element. The Examiner commits a factual error in alleging that the hydrophilic coating 14 of *Miyazawa* contacts a fluid distribution layer (FDL) in land regions to form an electrically conductive path between the electrically conductive element (ECE) and the FDL. Indeed, the obviousness rejection relies upon the Examiner's conjecture that *Miyazawa's* conductive hydrophilic polymer 14 would somehow not be fully removed from the sides of the lands, despite *Miyazawa* explicitly specifying that hydrophilic coating 14 is removed from lands (*i.e.,* contact surfaces) 23 to provide full contact of the rib 11 at its interface with the adjacent diffusion media. See Final Office Action, pp. 4 and 7-8.[1] See *Miyazawa* at ¶¶[0009], [0028], [0033], and [0040]. On this basis, the Examiner alleges that *Miyazawa's* conductive hydrophilic polymer 14 would remain on the sides of the lands and form an electrically conductive path along the lands between a FDL and ECE. See Final Office Action dated December 2, 2009, pages 7-8. Since the hydrophilic coating is not left on the lands; however, it fails to teach a hydrophilic coating disposed on the lands to form an electrically conductive path as claimed, regardless of whether it is present on the sidewalls.

Miyazawa teaches away from the claimed invention, because it prohibits the "hydrophilic membrane 14" from contacting electrodes so that any residual water

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[1] The pertinent portion of the Final Office Action on p. 4 states that "the hydrophilic layer is then removed from the very top surface of the separator's protrusions so the hydrophilic layer is left on the sidewalls and bottom surface of the separator (Fig. 2). When this top layer is removed, the edge portion of the hydrophilic layer on the sidewalls is even with the top surface of the separator. When the fuel cell is assembled and the gas distribution layer (appellant's FDL) is set on top of the separator, this edge portion of the hydrophilic layer on the sidewall will contact the FDL, thereby making both a fluid and electrical connection."

during shut down is fully drawn into grooves 7 to avoid diminishing initial power generation efficiency at low temperatures. ¶[0033]. *Miyazawa* describes applying the hydrophilic membrane coating 14 over the entire surface of the plate 4, but then in all embodiments removes it from the lands 23 of the ribs 11 by blasting in "Step S5" to achieve its stated objective. See ¶¶ [0033], [0040] and [0048]. *Miyazawa* attributes its success in increasing initial power generation efficiency by drawing water away from the porous rib 11 lands 23 via the hydrophilic membrane only being placed on the sidewalls and groove to avoid water freezing near the electrodes.

It is thus important to the invention of *Miyazawa* that there is no coating on the lands 23 to prevent water from freezing there. ¶¶[0003], [0005], [0029], [0033]. To this end, the rib 11 materials must have a preselected porosity to reduce thermal conductivity and avoid heat transfer from the gas diffusion electrode. ¶¶[0029], [0031]. *Miyazawa* specifies that avoiding placement of hydrophilic membrane 14 on the top face 23 of the rib 11 (contacting the MEA 20) avoids reductions in porosity, which would detrimentally impact the thermal conductivity. Accordingly, *Miyazawa* specifies that the conductive polymer matrix (14) is only applied to the walls (12) and bottom (13) of the grooves (7) and is removed from the surface that makes contact with the electrode. ¶¶[0009]-[0010]. See appended Figure 2 from *Miyazawa* reproduced below. Thus, *Miyazawa's* separator has uncoated low thermal conductivity ribs contacting the electrodes to localize heat for melting of ice. ¶[0010].

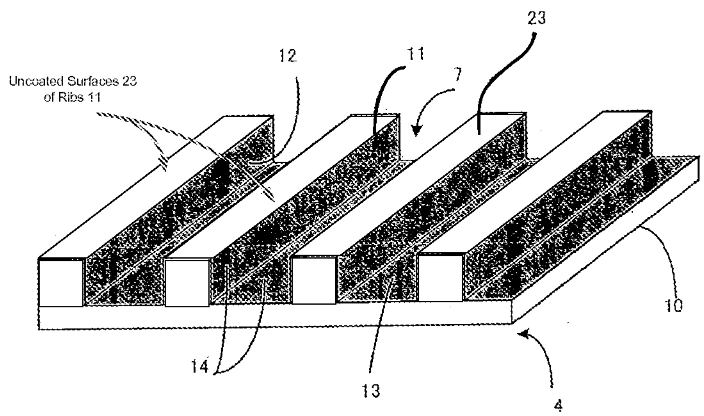

FIG. 2

While *Miyazawa* describes applying the hydrophilic membrane coating 14 over the entire surface of the plate 4, *Miyazawa* teaches the coating 14 must be removed from the lands 23 of the ribs 11 by blasting in "Step S5" to achieve its stated objective. See ¶¶ [0033], [0040] and [0048]; figures 2 and 3. More specifically, *Miyazawa* states that "[i]t should be noted that the hydrophilic coating on the top face 23 of the rib 11 is removed herein. A blasting method may be used in order to remove the hydrophilic coating. ... Thus, after the liquid or gel fills the gas flow groove 7, the hydrophilic membrane 14 is removed from areas not covered by the gel or the liquid by application of the blast process." ¶[0040]. The Examiner's supposition that hydrophilic membrane 14 inherently remains on the lands 23 the *Miyazawa* reference is not supported, because, as recognized by those of skill in the art, blasting at the junction with the walls 12 would not only remove the hydrophilic coating 14 on the land surfaces 23, but by the nature of the blasting process would more likely than not extend further down the walls 12 (thus removing a portion of the coating 14 from the upper regions of walls 12). *Miyazawa's* objective is to remove the coating, not allow it to remain; there is no basis for believing that the coating is not removed just as *Miyazawa* says. Inherency may not be legally established by probabilities or possibilities. The mere fact that a certain thing <u>may</u> result from a given set of circumstances is not sufficient. *In re Robertson*, 49 USPQ.2d

1949, 1951 (Fed. Cir. 1999). See also MPEP §2112(IV). Similarly, occasional results are insufficient to establish an inherent teaching. *See Mehl/Biophile International Corp. v. Milgraum*, 52 USPQ.2d 1303, 1306 (Fed. Cir. 1999). The fact remains that nothing in *Miyazawa* teaches leaving any portion of the membrane coating 14 on the contact surface 23 or having the membrane coating 14 establish any form of electrical contact with an adjacent fluid diffusion layer.

Nothing suggests to a skilled artisan any apparent reason to modify *Miyazawa* in the feature that is attributed to achieving its success. *Eisai Co. Ltd. v. Dr. Reddy's Labs., Ltd.*, 87 USPQ.2d 1452, 1456 (Fed. Cir. 2008); see also, *McGinley v. Franklin Sports*, 60 USPQ.2d 1001, 1010 (Fed. Cir. 2001) citing *In re Sponnoble*, 160 USPQ 237, 244 (CCPA 1969) (a combination of references which renders a prior art reference inoperable for its intended purpose is improper and does not support a *prima facie* case of obviousness). *Miyazawa* fails to provide any suggestion to modify its teachings in a manner that would render it unsuitable for its intended purpose (to avoid the hydrophilic membrane from contacting the land regions of the rib to prevent water freezing near the electrode to cause power inefficiency during start-up). Accordingly, the *Miyazawa* reference teaches away from the proposed modification of applying hydrophilic membrane 14 to the rib surfaces that contact the diffusion media/electrodes, because in carrying out such a modification, *Miyazawa* would be rendered unsuitable for its intended purpose.

3. <u>*Yamada* also fails to teach a conductive porous liquid distribution media (LDM) of Claims 1-2, 5, 8-11, 16-21, and 23.</u>

Yamada does not account for the deficiencies of the *Miyazawa* reference. The Examiner relies upon the external liquid wicking system of *Yamada* for "how to make multiple layers having different pore sizes such that water is pulled away from the

cathode." Final Office Action dated December 2, 2009, p. 8. Yet, *Yamada* fails to remedy the shortcomings of the *Miyazawa* reference. *Yamada* does not teach or suggest an electrically conductive liquid distribution media disposed between an impermeable separator plate and a fluid distribution layer integrated within the electrically active flow fields of the electrochemical cell to transport and redistribute liquids accumulating within the cathode. Further, *Yamada* fails to provide any apparent reason to modify *Miyazawa's* hydrophilic groove/sidewall coating to make it porous. Even more importantly, nothing in *Yamada* provides a person of ordinary skill in the art with any apparent reason to modify *Miyazawa* to dispose an electrically conductive porous liquid distribution media on lands to establish an electrically conductive path between the FDL and impermeable separator plate.

First, *Yamada* fails to describe a conductive liquid distribution media; rather *Yamada* describes porous, non-conductive, water-collecting "wicking" materials that are external to a fuel cell. *Yamada* places an electrically insulated water-recovering wick 35 along an exterior of the fuel cell that only touches an outer edge of the oxidizing electrode 38 (Figure 1), and a non-conductive water-retaining wick 41 is disposed inside a water-storing receptacle outside of the fuel cell. Col. 38, lines 6-27, Nos. 35 and 41 of Figures 21, 23. These external transport systems in *Yamada* serve to wick liquid fuel and water to and from the electrodes of the MEA, but are made of electrically non-conductive "inorganic or organic fibers" that are not suitable for use in the active regions of the fuel cell that experience harsh conditions (including acids, electrical potential, and the like) not found outside the fuel cell. *See e.g.*, col. 38, lines 18-20.

Contrary to teaching making the wicks of an electrically conductive material that might be suitable for use on the lands of an impermeable separator plate, *Yamada* explicitly teaches away from using an electrically conductive wicking material. Indeed, the Examiner acknowledges that *Yamada* teaches away from a water wicking material

having electrical conductivity, since *Yamada* specifies that "the materials for the wicks [to transport liquids] are not allowed to be conductors because conductors possibly form a cause for a short circuit." Col. 47, lines 10-15; *see also*, col. 38, lines 8-9 and 67-68; and col. 39, lines 21-25. See Final Office Action date December 2, 2009, pages 12-13. To account for this deficiency, the Final Office Action dated December 2, 2009 on pp. 9-10 cites various sections of *Yamada* pertaining to porous electrode materials to allegedly show that "Yamada <u>does</u> teach particular pore sizes for the porous material in the active region of the fuel cell."

The cited sections of *Yamada* pertain to formation of porous membrane electrode assemblies, including anodes, cathodes, polymer electrolyte membranes, and porous separator elements. See Final Office Action date December 2, 2009, pages 12-13. For example, cited col. 16, lines 25-40 of *Yamada* describes porosity of the separator element situated between respective cells (notably in embodiments where there is no impermeable separator, as claimed), which is a wholly distinct element from a liquid distribution element. Cited col. 24, lines 14-20 relates to porosity of the electrodes (which must be porous, because it is a liquid fuel cell). While this section discusses the porosity of electrodes in direct contact with external liquid wicking materials and the porosity of such external wicking channels for drawing liquid outside the electrode and fuel cell, it provides no suggestion with regard to porosity of a potential liquid distribution media having a different function and situated in an entirely different position between a fluid distribution layer and an impermeable separator element defining flow channels for transporting a mixture of gas and liquids. This cited discussion in *Yamada* pertains to the materials used in the specialized function of the MEA, which requires constant localized reactant flow to active materials like catalysts and/or the electrolyte membrane at specific pressure conditions to generate electric potential via the fuel cell reactions; however, which has little applicability to a liquid

distribution media contacting a fluid distribution layer (FDL) and an impermeable separator element.

Likewise, the nickel mesh cited by the Examiner in *Yamada* is used as an electrode collector, which is thermocompression bonded on opposite surfaces of the polymeric membrane, and has no apparent applicability whatsoever to wicking materials or liquid distribution media. If anything, *Yamada's* discussion would lead one of ordinary skill in the art to modify the membrane electrode assembly (MEA) of *Miyazawa,* but the cited discussion of porosity in *Yamada* fails to provide any apparent reason to arrive at the claimed porous electrically conductive liquid distribution media disposed between and forming an electrically conductive path between an impermeable electrically conductive element and a fluid distribution layer.

4. <u>*Yamada* teaches away from modifying *Miyazawa* to have an electrically conductive porous liquid distribution media (LDM) on lands of an impermeable separator element to form electrically conductive paths inside the fuel cell of Claims 1-2, 5, 8-11, 16-21, and 23.</u>

While *Yamada* provides liquid-fuel cells that can contain a porous separator plate or an external liquid wicking material to distribute liquids to and from the fuel cell and liquid storage reservoirs, *Yamada* has no teaching or suggestion to use any particular porous or conductive materials like the claimed liquid distribution media inside the active regions of the fuel cell to transport gases and liquids concurrently. Indeed, nothing in *Yamada* would suggest configuring the claimed LDM element to be disposed internal to the fuel cell. As discussed above, *Yamada* teaches that the wicking material must be electrically non-conductive and placed externally to the fuel cell. While *Yamada* discusses the porosity of electrodes, a person of ordinary skill in the art would view an electrode to be distinct in both position and function from the claimed liquid

distribution media. Nothing in *Yamada* teaches or suggests disposing an electrically conductive LDM on a land of an impermeable electrically conductive element (ECE), thus forming an electrically conductive path between the ECE and a fluid distribution layer (FDL).

Yamada fails altogether to describe in any way a liquid distribution media disposed on a major surface of the ECE, including on the lands, that confronts the FDL. Thus, *Yamada* does not account for the elements lacking in *Miyazawa*, namely i) a porous liquid distribution media that is ii) disposed on lands of the major surface of the ECE to form an electrically conductive path between the ECE and FDL. Instead, *Yamada* teaches a wicking material disposed next to a fuel cell, not internal to the fuel cell. Col. 38, lines 6-27, Nos. 35 and 41 of Figures 21, 23. While *Yamada* describes external transport systems for wicking liquid fuel and water to and from the electrodes of the MEA, the water-recovering wick must be in direct contact with the electrode and thus, must be electrically non-conductive. Upon reading the *Yamada* reference, which specifies using a non-conductive wick external to the fuel cell, a person of ordinary skill in the art would be led in a divergent path from the one claimed. A person of ordinary skill in the art would be led to instead provide liquid management from the electrodes by direct contact with a non-conductive external wicking network at the periphery of the fuel cell to transport liquids.

Further, nothing in the cited references suggests that the LDM should be disposed on lands to create electrically conductive paths between an adjacent fluid distribution layer and impermeable electrically conductive element. *Miyazawa* teaches removing its non-porous hydrophilic coating from the land surfaces to avoid contact with an adjacent fluid distribution layer. *Yamada* fails to suggest anything with regard to such a liquid distribution media, including failing to provide any apparent reason to leave the hydrophilic coating on lands. The Examiner has articulated no reasons why

one of ordinary skill in the art would modify *Miyazawa* to be a porous liquid distribution membrane or to include such a liquid distribution medium on lands of an impermeable separator plate. Here, there can be no *prima facie* case of obviousness where one cited reference (*Miyazawa*) teaches away from a claimed feature (coating on the lands) and the other reference (*Yamada*) fails to explain or address the teaching away in any regard, so that one of ordinary skill in the art would only have a clear teaching away from a modification that would lead to the claimed invention.

As such, whether considered independently or as combined, *Miyazawa* and *Yamada* fail to support a *prima facie* case of obviousness for Claims 1-2, 5, 8-11, 16-21, and 23 and the rejection should be reversed.

B. A *prima facie* case of obviousness has not been established for Claims 12, 51, 53, 55-63, 65, and 75, because *Miyazawa* and *Yamada* fail to teach or provide any apparent reason to provide a liquid distribution media having two distinct layers.

In addition to the reasons described above in the context of independent Claim 1, for these further reasons dependent Claims 12 and 65, independent Claim 51 and its dependent Claims 53, 55-63, and 75, are not rendered *prima facie* obvious by *Miyazawa* in view of *Yamada*. Nothing in *Miyazawa* or *Yamada* teaches or suggests a liquid distribution media (LDM) comprising both a first layer that contacts an impermeable electrically conductive separator plate (ECE), as well as an additional second layer that contacts the fluid distribution layer (FDL). Further, nothing in the cited references suggests having the LDM's first layer be less hydrophilic than the LDM's second layer, as claimed.

The Examiner misinterprets *Miyazawa* to teach two electrically conductive porous layers. *Miyazawa* fails to teach even a single porous layer as discussed in the context of Claim 1, nonetheless two distinct porous layers as recited in Claim 51, for example. See Final Office Action dated December 2, 2009, page 8. The Examiner states that *Yamada* teaches how to make multiple layers having different pore sizes to pull water away from the cathode. While *Yamada* does describe different pore sizes, nowhere does *Yamada* describe two distinct porous layers arranged in horizontal layers in an active flow field handling high flow rates of liquids and gases. *Yamada* states that a water-recovering wick (or a first adjoining water absorbing means) contacts the oxidizing electrode 38 and extends along a water recovery chamber 35 leading to a water-retaining wick (or a second adjoining water absorbing means) leading to a water-storing space 41, which may have a reduced porosity as compared to the water-recovering wick to promote water flow in the desired direction. *See, e.g.*, col. 9, line 67- col. 10, line 17; col. 10, lines 43-59; col. 38, lines 3-34; figs. 21 and 23. The placement of wicking materials of different porosities in a water flow channel and a storage reservoir adjacent to one another along the water flow pathway does not teach or suggest the claimed invention. *Yamada* contains no teaching or suggestion to provide a liquid distribution media (LDM) inside the fuel cell that comprises both a first horizontal layer contacting an impermeable electrically conductive separator plate (ECE), as well as an additional second horizontal layer that contacts the fluid distribution layer (FDL), where these layers are co-extensive with one another. The porous wicks of *Yamada* are next to one another in a flow path and designed to have different pore sizes to draw liquids along the flow channel to an external reservoir (Col. 9, line 63 – Col. 10, line 17), but this discussion pertains to these wicking materials external of any active region of the active fuel cell.

Furthermore, neither *Miyazawa* nor *Yamada* teaches or suggests a porous FDL having an average pore size larger than an average pore size of the second layer of the LDM, where the first layer of the LDM (contacting the ECE) is less hydrophilic than the second layer (contacting the FDL). This configuration contradicts *Yamada's* teaching, which states that the average pore diameter should decrease (to increase hydrophilicity) in the direction of flow of the water (Col. 10, lines 16-17; Col. 38, lines 10-11, 24-27). Yet, in direct contrast, Claims 51, 53, 55-63 and 75 call for a first layer contacting the impermeable electrically conductive element (ECE) having a lower hydrophilicity than the second layer that is closest to and contacts the FDL (where water flows down to the first layer next to the ECE for enhanced transport and removal from the active region). In other words, the claimed LDM configuration directly contradicts what is suggested by the art. In view of *Yamada's* teaching away of this configuration, one of ordinary skill would have neither any apparent reason nor any expectation of success to arrange a less hydrophilic first layer of the LDM situated farthest away from the FDL (contacting the ECE) than a second layer closest to and contacting the FDL having greater hydrophilicity. For these additional reasons, Applicants respectfully that a *prima facie* case of obviousness has not been established for Claims 12, 51, 53, 55-63, 65, and 75 and the rejection should be reversed.

C. A *prima facie* case of obviousness has not been established for Claims 15, 64-66 And 68-74, because the combination of *Miyazawa* and *Yamada* fails to teach or suggest a liquid distribution media formed from a mesh, a screen, a foam or a sintered metal material.

In addition to the reasons discussed above for Claim 1, regarding dependent Claim 15, independent Claim 64 and its dependent Claims 65-66 and 68-74, *Miyazawa* and *Yamada* collectively fail to teach or suggest an LDM comprising a material selected from the group consisting of: mesh, screen, foam, and sintered metal. The Examiner

cites a nickel mesh described in *Yamada* (col. 47, lines 40-45); however, this discussion does not pertain in any way to a wicking material or a liquid distribution media. Rather, *Yamada* describes it as an electrode collector that is thermo-compression bonded to a catalyst, fluorocarbon, and the membrane. Such an electrode collector mesh provides no apparent reason to a person of ordinary skill in the art to use such a nickel metal mesh material as a liquid distribution media as claimed, particularly where *Yamada* teaches that an electrically conductive material is not suitable as a wicking material. Nothing in the cited art teaches an LDM comprising a material selected from the group consisting of: mesh, screen, foam, and sintered metal. A *prima facie* case of obviousness has not been established for any of Claims 15, 64-66 and 68-74. Accordingly, the Examiner's final rejections of Claims 15, 64-66 and 68-74 should be reversed.

D. None of the cited references teaches or suggests a liquid distribution media disposed in regions of the major surface corresponding to an electrically active area defined by the MEA as in Claims 7, 55 and 68.

Claims 7, 55, and 68 are further patentable over the cited art because they call for a conductive porous liquid distribution media disposed in regions along the major surface corresponding to an electrically active area defined by the MEA. As discussed above in the context of claim 1, *Miyazawa* fails to provide a porous liquid distribution media on an impermeable electrically conductive element (ECE). While *Miyazawa* describes a hydrophilic membrane 14 disposed in grooves, it is removed from land contact surfaces 23 to optimize fuel cell start-up performance and prevent freezing of water near the MEA, as described in the context of independent Claim 1. Hence, *Miyazawa* does not suggest that the hydrophilic membrane 14 is porous or that it is disposed on a major surface corresponding to an electrically active area defined by the MEA, including land surfaces, to form an electrically conductive path between a fluid

distribution media and an impermeable electrically conductive element in regions corresponding to the lands. *Yamada* specifies that the wicking materials are non-conductive and external to the active area of the fuel cell to prevent short-circuiting.

Thus, the combination of *Miyazawa* and *Yamada* fails to suggest in any way the modifications necessary to arrive at a porous liquid distribution media disposed in regions along the major surface corresponding to an electrically active area defined by the MEA. There can be no *prima facie* case of obviousness where one cited reference (*Miyazawa*) teaches away from a claimed feature (coating on the regions along the major surface corresponding to an electrically active area defined by the MEA) and the other reference (*Yamada*) fails to explain or address the teaching away in any regard, but rather also teaches away from such an embodiment. One of ordinary skill in the art would only find a clear teaching away from a modification that would lead to the claimed invention. Thus, the obviousness rejection of Claims 7, 55, and 68 should be reversed.

E. None of the cited references teaches or suggests a liquid distribution media forming an undulated surface of lands and grooves as recited in Claims 8, 56 And 69.

Claims 8, 56, and 69 are further patentable over the cited art because they provide an impermeable electrically conductive element that is planar and a body of the liquid distribution media defines an undulated configuration of peaks and valley, where the peaks correspond to lands and the valleys correspond to grooves to form flow channels of reactants to the electrochemical cell. The Examiner has failed to point to any portion of the *Miyazawa* and/or *Yamada* references that describes or suggests such a feature. The *Miyazawa* reference merely describes coating discrete regions of a surface with a hydrophilic layer 14, but explicitly teaches away from its coating remaining on the lands. (As discussed above in regard to Claim 1, the hydrophilic layer 14 is always

removed from electrical contact regions/lands 23 of ribs 11.) *Yamada* specifies placing the porous wicking material outside the active fuel cell area and further specifies that such a wicking material must be electrically non-conductive. Hence, there is no teaching or suggestion in either *Miyazawa* or *Yamada* to create lands and valleys that form the flow channels with the liquid distribution media in a fuel cell.

Additionally, *Miyazawa* and *Yamada* teach away from the configuration recited in Claims 8, 56, or 69. As described previously above, *Yamada* teaches away from using a wicking material as an electrically conductive land in accordance with the configuration of Claims 8, 56, or 69. Hence, a *prima facie* case of obviousness has not been established for any of Claims 8, 56, or 69 by either *Miyazawa* or *Yamada*, whether considered individually or when combined.

F. Claim 22 is not rendered obvious by the combination of *Miyazawa*, *Yamada* and *Davis* because neither *Miyazawa* nor *Yamada* teaches a porous conductive liquid distribution media disposed on a land forming an electrically conductive path between the impermeable electrically conductive element and the fluid distribution layer, both *Miyazawa* nor *Yamada* references teach away from such a configuration, and *Davis* provides no teaching or guidance to modify these references in the manner required.

Claim 22 depends upon Claim 1. For the reasons set forth above in the context of Claim 1, Claim 22 is not rendered obvious by either *Miyazawa* or *Yamada*. As set forth in the context of Claim 22, *Miyazawa* and *Yamada* do not teach or otherwise provide any apparent reason for a person of ordinary skill in the art to provide an impermeable electrically conductive element having a porous electrically conductive distribution media on its lands. Nothing in *Miyazawa* or *Yamada* suggest the porous electrically conductive liquid distribution media forming an electrically conductive path between the electrically conductive element and the fluid distribution layer. Further, as

discussed in the context of Claim 1, *Miyazawa* and *Yamada* teach away from such a modification. The *Davis* reference fails to account for the deficiencies of these references and accordingly, Claim 22 should be allowed.

VIII. Conclusion

The present claims are patentable over the cited art.

As discussed above, the Examiner has not met the burden necessary under applicable law to demonstrate that the claims are rendered obvious over the cited art.

Appellants, therefore, respectfully ask this Honorable Board to reverse the final rejections of the claims on each ground and to indicate that all appealed claims are allowable.

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Respectfully submitted,

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CLAIMS APPENDIX

Claims Involved in the Appeal of Application Serial No. 10/780,025

LISTING OF CLAIMS

1. An electrochemical cell having a membrane electrode assembly (MEA) comprising an anode and a cathode, the cell comprising:

an electroconductive element comprising an impermeable electrically conductive element having a major surface facing the cathode, and an electrically conductive porous liquid distribution media disposed along said major surface defining flow channels comprising lands and grooves for transporting gas and liquid to and from the cathode;

an electrically conductive fluid distribution layer disposed between said liquid distribution media and the cathode for transporting gases and liquids between the cathode and said flow channels; said fluid distribution layer and liquid distribution media constructed and arranged to transport liquids accumulating within the cathode through said fluid distribution layer and to and through said liquid distribution media, wherein said liquid distribution media contacts said fluid distribution layer in regions corresponding to said lands to form an electrically conductive path between said impermeable electrically conductive element and said conductive fluid distribution

layer, and wherein said fluid distribution layer is porous and has an average pore size larger than an average pore size of said porous liquid distribution media.

2. The electrochemical cell of claim 1, wherein said impermeable electrically conductive element and said liquid distribution media are arranged together to define said flow channels.

5. The electrochemical cell of claim 1, wherein said liquid distribution media is more hydrophilic than said fluid distribution layer.

7. The electrochemical cell of claim 1, wherein said liquid distribution media is disposed in regions along said major surface corresponding to an electrically active area defined by the MEA.

8. The electrochemical cell of claim 1, wherein said impermeable electrically conductive element is planar and a body of said liquid distribution media defines an undulated configuration of peaks and valleys, wherein said peaks correspond to said lands and said valleys correspond to said grooves which constitute said flow channels.

9. The electrochemical cell of claim 1, wherein said porous liquid distribution media has an average pore size in the range of from about 0.2 to about 30 micrometers.

10. The electrochemical cell of claim 1, wherein said liquid distribution media internally re-distributes liquid water thereby minimizing differences in humidity along a face of the MEA.

11. The electrochemical cell of claim 1, wherein said electroconductive element comprises a second impermeable electrically conductive element having a second surface facing the anode and a second liquid distribution media that is attached along regions of said second surface, and a second fluid distribution layer is disposed between said electroconductive element and the anode, wherein said second liquid distribution media contacts said second fluid distribution layer.

12. The electrochemical cell of claim 1, wherein said liquid distribution media comprises a first and a second layer wherein said first layer is in contact with said impermeable electrically conductive element and said second layer is in contact with said fluid distribution layer wherein said second layer is more hydrophilic than said first layer.

15. The electrochemical cell of claim 1, wherein said liquid distribution media is selected from the group consisting of: mesh, screen, and foam.

16. The electrochemical cell of claim 1, wherein said liquid distribution media is constructed of material selected from the group consisting of: carbon, graphite, polymers, stainless steel, chrome and alloys and mixtures thereof.

17. The electrochemical cell of claim 1, wherein said liquid distribution media is formed of materials that are cast, coated, or sprayed onto said major surface.

18. The electrochemical cell of claim 1, wherein said liquid distribution media comprises a conductive polymer or a non-conductive polymer with conductive particles distributed therein.

19. The electrochemical cell of claim 18, wherein said liquid distribution media is cured by application of heat.

20. The electrochemical cell of claim 1, wherein said liquid distribution media comprises a plurality of conductive metal particles selected from the group consisting of: stainless steel, niobium, nickel-chromium-iron alloy, and mixtures thereof.

21. The electrochemical cell of claim 20, wherein said liquid distribution media is formed by sintering said plurality of conductive metal particles by application of heat.

22. The electrochemical cell of claim 1, wherein said impermeable electrically conductive element comprises a compound selected from the group consisting of: aluminum, titanium, stainless steel, and alloys and mixtures thereof.

23. The electrochemical cell of claim 1, wherein said liquid distribution media is formed by etching said major surface.

51. An electrochemical cell having a membrane electrode assembly (MEA) comprising an anode and a cathode, the cell comprising:

an electroconductive element comprising an impermeable electrically conductive element having a major surface facing the cathode, and an electrically conductive porous liquid distribution media disposed along said major surface defining

flow channels comprising lands and grooves for transporting gas and liquid to and from the cathode;

an electrically conductive fluid distribution layer disposed between said liquid distribution media and the cathode for transporting gases and liquids between the cathode and said flow channels; said fluid distribution layer and liquid distribution media constructed and arranged to transport liquids accumulating within the cathode through said fluid distribution layer and to and through said liquid distribution media, wherein said liquid distribution media comprises a first layer and a second layer arranged so that said first layer contacts said impermeable electrically conductive element and said second layer contacts said fluid distribution layer in regions corresponding to said lands to form an electrically conductive path between said impermeable electrically conductive element and said conductive fluid distribution layer, and wherein said fluid distribution layer is porous and has an average pore size larger than an average pore size of said second layer of said porous liquid distribution media, and said first layer of said liquid distribution media is less hydrophilic than said second layer.

53. The electrochemical cell of claim 51, wherein said impermeable electrically conductive element and said liquid distribution media are arranged together to define said flow channels.

55. The electrochemical cell of claim 51, wherein said liquid distribution media is disposed in regions along said major surface corresponding to an electrically active area defined by the MEA.

56. The electrochemical cell of claim 51, wherein said impermeable electrically conductive element is planar and a body of said liquid distribution media defines an undulated configuration of peaks and valleys, wherein said peaks correspond to said lands and said valleys correspond to said grooves which constitute said flow channels.

57. The electrochemical cell of claim 51, wherein said liquid distribution media is selected from the group consisting of: mesh, screen, and foam.

58. The electrochemical cell of claim 51, wherein said liquid distribution media is constructed of material selected from the group consisting of: carbon, graphite, polymers, stainless steel, chrome and alloys and mixtures thereof.

59. The electrochemical cell of claim 51, wherein said liquid distribution media is formed of materials that are cast, coated, or sprayed onto said major surface.

60. The electrochemical cell of claim 51, wherein said liquid distribution media comprises a conductive polymer or a non-conductive polymer with conductive particles distributed therein.

61. The electrochemical cell of claim 60, wherein said liquid distribution media is cured by application of heat.

62. The electrochemical cell of claim 51, wherein said liquid distribution media comprises a plurality of conductive metal particles selected from the group consisting of: stainless steel, niobium, nickel-chromium-iron alloy, and mixtures thereof.

63. The electrochemical cell of claim 62, wherein said liquid distribution media is formed by sintering said plurality of conductive metal particles by application of heat.

64. An electrochemical cell having a membrane electrode assembly (MEA) comprising an anode and a cathode, the cell comprising:

an electroconductive element comprising an impermeable electrically conductive element having a major surface facing the cathode, and an electrically

conductive porous liquid distribution media disposed along said major surface defining flow channels comprising lands and grooves for transporting gas and liquid to and from the cathode;

an electrically conductive fluid distribution layer disposed between said liquid distribution media and the cathode for transporting gases and liquids between the cathode and said flow channels; said fluid distribution layer and liquid distribution media constructed and arranged to transport liquids accumulating within the cathode through said fluid distribution layer and to and through said liquid distribution media, wherein said liquid distribution media contacts said fluid distribution layer in regions corresponding to said lands to form an electrically conductive path between said impermeable electrically conductive element and said conductive fluid distribution layer and wherein said liquid distribution media comprises a material selected from the group consisting of: mesh, screen, foam, and sintered metal.

65. The electrochemical cell of claim 64, wherein said liquid distribution media comprises a first and a second layer wherein said first layer is in contact with said impermeable electrically conductive element and said second layer is in contact with said fluid distribution layer in regions corresponding to said lands, wherein said second layer is more hydrophilic than said first layer.

66. The electrochemical cell of claim 64, wherein said impermeable electrically conductive element and said liquid distribution media are arranged together to define said flow channels.

68. The electrochemical cell of claim 64, wherein said liquid distribution media is disposed in regions along said major surface corresponding to an electrically active area defined by the MEA.

69. The electrochemical cell of claim 64, wherein said impermeable electrically conductive element is planar and a body of said liquid distribution media defines an undulated configuration of peaks and valleys, wherein said peaks correspond to said lands and said valleys correspond to said grooves which constitute said flow channels.

70. The electrochemical cell of claim 64, wherein said liquid distribution media is constructed of material selected from the group consisting of: polymers, stainless steel, chrome and alloys and mixtures thereof.

71. The electrochemical cell of claim 64, wherein said liquid distribution media is formed of materials that are cast, coated, or sprayed onto said major surface.

72. The electrochemical cell of claim 64, wherein said liquid distribution media comprises a conductive polymer or a non-conductive polymer with conductive particles distributed therein.

73. The electrochemical cell of claim 72, wherein said liquid distribution media is cured by application of heat.

74. The electrochemical cell of claim 64, wherein said liquid distribution media comprises a plurality of conductive metal particles selected from the group consisting of: stainless steel, niobium, nickel-chromium-iron alloy, and mixtures thereof, that are sintered to form said liquid distribution media.

75. The electrochemical cell of claim 51, wherein said liquid distribution media has an average pore size of about 0.2 to about 30 micrometers.

EVIDENCE APPENDIX

Evidence Pursuant to §§ 1.130, 1.131, or 1.132 or Entered by or Relied Upon by the Examiner being Submitted in the Appeal of Application Serial No. 10/780,025.

NONE

RELATED PROCEEDINGS APPENDIX

Proceedings Related to the Appeal of Application Serial No. 10/780,025.

NONE